Verification and Validation of Radiation Transport Schemes

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As part of the Advanced Simulation and Computing (ASC) Verification and Validation program, we have conducted a number of tests on radiation transport schemes in ASC codes. These tests include a range of problems and a variety of algorithms. In this brief summary, we discuss the methodology behind these studies using one specific code test as an example.

Verification of a code can be done in a number of ways: convergence studies (in space, in time, in tolerance settings, etc.) and comparisons of results (e.g., with an experiment or an analytic result or between two different codes or algorithms). Note that comparison with an experiment may also serve to "validate" a code, but not all code-to-experiment comparisons are validation tests [1,2]. We utilize many of these techniques in our tests.

The example in this paper illustrates three verification techniques: code/algorithm comparison, code/experiment comparison, and a convergence study. The experimental setup takes the radiation released by a Sandia Z dynamic Hohlraum source and studies the propagation of the radiation through a target. The radiation flows down a taper into an aerogel foam. The resultant shock is then backlit to provide an image. The first suite of these experiments has already been performed, providing an ideal set of results for comparison.

Figure 1 shows the density contour from our calculations for this experiment at a set time after the injection of the radiation. The top panel shows a comparison between a certain set of input parameters (right half) versus the latest and greatest set of input parameters (left half) for our code. In a sense, we have just done a code-to-code comparison in this top panel even though the actual code used was the same, but the exact numerical implementation within this code changed. We also compared these results to the experiment and found agreement at the 10–20% level, within the error of the experimental setup. The bottom panel of Fig. 1 shows a comparison of the calculation results for simulations using two different resolutions, one in 2-D, and the other in 3-D. Again, the good agreement implies both that we are converged and that 3-D effects are not too critical for this particular problem setup.

Our simulations are part of a recently completed Level 2 ASC milestone, and our future simulations will continue to play a role in major verification and validation milestones.

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[1] C.L. Fryer, et al., *Ap. J.* **643**, 292 (2006).
[2] C.L. Fryer, et al., "Supernova Explosions: Understanding Mixing" (submitted to *Int. J. Mod. Phys. D*).

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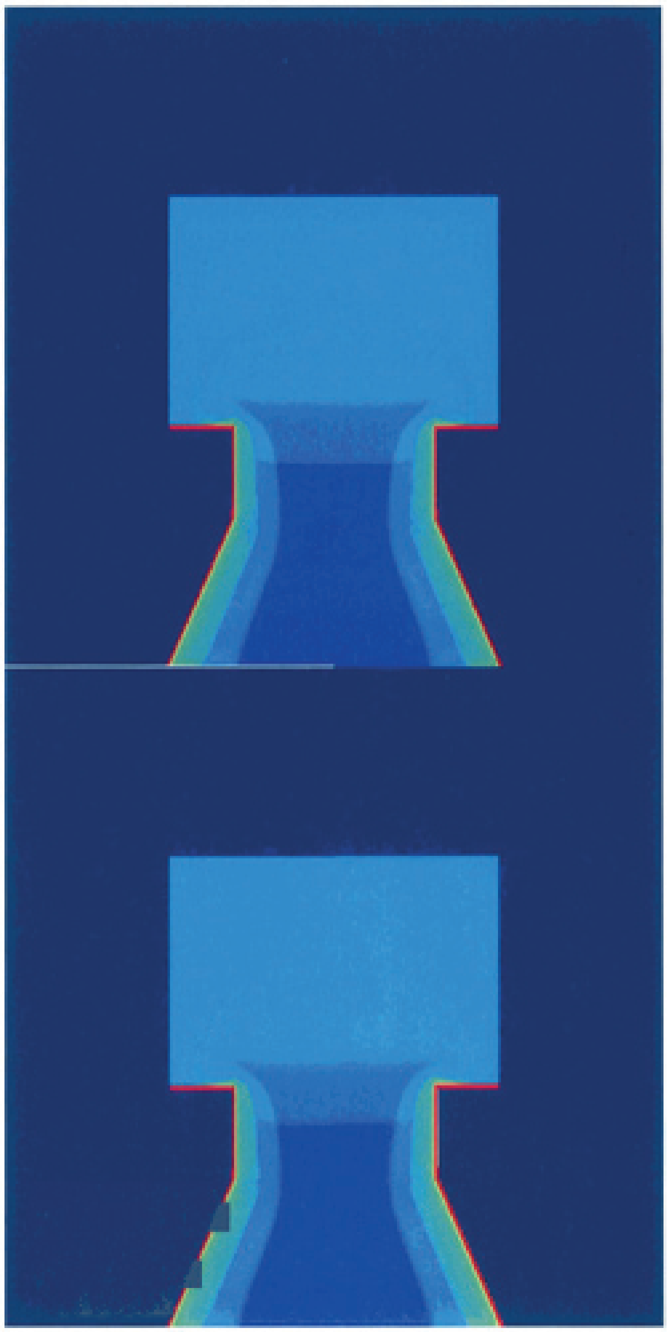

Fig. 1.
Plots of density for four separate calculations of our experimental setup. Top left: parameters from latest release from milestone project. Top right: old simulation. Bottom left: normal resolution. Bottom right: low resolution.